User-driven design of robot costume for child-robot interactions among children with cognitive impairment

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Abstract. The involvement of arts and psychology elements in robotics research for children with cognitive impairment is still limited. However, the combination of robots, arts, psychology and education in the development of robots could significantly contribute to the improvement of social interaction skills among children with cognitive impairment. In this article, we would like to share our work on building and innovating the costume of LUCA's robot, which incorporating the positive psychological perspectives and arts values for children with cognitive impairment. Our goals are (1) to educate arts students in secondary arts school on the importance of social robot appearance for children with cognitive impairment, and (2) to select the best costume for future child-robot interaction study with children with cognitive impairments. In this study, we worked together with teachers and students from secondary art school in Ghent, Belgium. Two designs which obtained the highest evaluation score were selected based on some design criteria which are, (1) psychological perspectives, (2) design simplicity, (3) design safety and (4) robot's fitting.

Keywords: Robot, Arts , Psychology, Education, Child-Robot Interaction

1 Introduction

Robots, educations, arts and psychology need to be integrated in social robot research since it could bring a huge impact to the affected children especially children with cognitive impairment (CWCI) [1, 2, 4, 11]. Robots are well-known to be a mechanical device or machine that being control autonomously or remotely by electrical components and power. Robots also should be equipped with some intelligence based on certain sensors attached to its body. Most of the physical robots are lacking of arts values despite of their advance technological

capabilities and intelligence. The gaps between arts and robotics are huge. Arts could be defined as the science of creativity and imagination especially in visual and graphical representation such as painting, music, literature and etc [6]. However, the elements of arts could add more value to the appearance of social robots [15, 16] in term of creating more interesting, attractive and appealing robots. The appearance of some robot could be a positive agent and function as a "catalyst" towards improving social interaction skills in child-robot interaction [13, 17]. As the research evolved across interdisciplinary fields, psychology has become a close friend to the robotics research especially in the domain of social robotics. Psychology is the scientific study of behaviour and mind; be it in a conscious state or subconscious mind [5]. In social robotics research, psychology perspectives are very important since it could affect the output of child-robot interaction in a positive or negative substances [9]. Thus, providing good psychological perspectives [21] in child robot interaction are crucial and vital in ensuring the study shall benefits the target group such as children with cognitive impairment.

In this study, we worked together with the secondary art students to build the robot's costume for future child-robot interaction between LUCA robot and CWCI. Thus, it is important to merge the arts value and psychological perspective in the child-robot interaction experiment. Beside that, it is also interesting to have the robot's costume made by another children. In fact, one of the art students, was also diagnosed to have mild autism. However, she had followed some intervention programs and has improved her mild impairments a lot. This user-driven design of robot costume is also laterally performed in order to wind up our aspiration in educating the secondary art students in Ghent, Belgium on the significance of arts and psychology aspects in child-robot interaction. The objectives of this project are (1) to educate art students in Secondary Arts School on the importance of arts elements in social robotics appearance for children with cognitive impairment, and (2) to select the best two costumes for future child-robot interaction study with children with cognitive impairments.

Thus, this paper discusses the importance of youngster's education and creating more awareness towards integration of robots, education, arts and psychology. Moreover, the design process of the robot costumes with art teachers and students will be further elaborated in the next section. Then, all the costumes of LUCA robot will be illustrated and discussed in the following section. Last but not least, we will conclude this paper with some of our plan for the future work on child-robot interaction with children with cognitive impairment.

2 Incorporating arts and psychology in social robots

As mentioned in earlier section, we were trying to be innovative in this study by integrating component of arts, psychology, robotics and education. Thus, we modified an open source robot based on the OPSORO platform [18–20] since it is very affordable and could achieve the objectives of our study. The robot, namely as LUCA is a special robot since it could do some basic facial expressions

such as happy, sad, angry and etc. LUCA has 16 degree of freedom and capable of turning his head and wave his small arms up and down. Moreover, LUCA is equipped with kinect sensor for visual recording purposes. Besides that, LUCA has one mobile NVIDIA Jetson TX1 as its 'brain' and can perform some basic computational analysis in real-time.

In this study, we asked some advises from certified clinical occupational therapists on what are the important aspects in psychological appearance [7] of the robot when interacting with children diagnosed with cognitive impairment. Visual and appearance aspects of the robot are among the important things when designing the costume of the robot for child-robot interaction study. Thus, the color of robot's costume for this study was selected based on finding from Grandgeorge et al. [8]. Students were given several color's option to be used in their design such as blue, red, yellow and brown. They were free to choose these colors to match with their design of LUCA's costume.

3 Design of Robot's Costume

3.1 Define the problem

In this stage, 11 children from one of the secondary art school in Belgium were briefly explained their task. The context of how the costume will be used in the future work or experiment with children with cognitive impairment were carefully explained to the participating teachers and students. Basically, children diagnosed with cognitive impairment suffered from concentration difficulties, attention deficit, learning disabilities, cognitive decline and reduction in mental function[12]. In future studies, their costume will be used to help affected children in interacting with the robot. LUCA robot will perform some basic tasks during child-robot interaction with children with cognitive impairment such as facial expressions guess-game, head-turns and etc. The students were briefed about what they need to consider and some importance aspect in designing the costume of the robot (1) psychological perspectives, (2) design simplicity, (3) design safety and (4) robot's fitting. These aspects are very important for future study of child-robot interaction. Thus, they are allowed to discuss among them and brainstorm their idea for the design of LUCA's costume.

3.2 Costume Design Criteria

In this process, it is interesting to see how secondary arts students brainstorm their ideas and innovative thought together based on inputs given to them by postgraduate student, teacher and professor. As mentioned earlier, the input that was given to the students is summarize as below:

1. **Psychological perspectives**: The selection of colour for robots costume must have some psychological effects [8] towards children with cognitive impairment.
2. **Design simplicity**: The design should be simple but interesting [14].

3. **Design safety**: No dangerous materials shall be used in fabricating the costume such as metal and hazardous items [10].
4. **Robot's fitting**: The fitting of the costume shall not distract the robots capabilities and functions [3] (i.e. facial expressions, no design obstacle for robot's head to turns left and right.)

3.3 Costume Design Process

Various aspects and perspectives have been considered in integrating arts, robots, education and psychology. In this study, the work of creating the robots costume were carried out by young, bright and talented secondary arts students. There are several important processes in building the costume for LUCA robot (1) Measure the robot's dimension (2) fabrics selection and cutting (3) Sewing (4) Fitting (5) Final trimming.

Fig. 1: Figure shows the student tried their best to test their robot's costume on the actual robot.

Fig. 2: All costumes prototypes made by art students in Ghent, Belgium

Measure: During this process, students came to the robotics laboratory and manually took the dimension of lower body and upper body of the robot.

Fabrics selection and cutting: Most of the students decided to used soft fabrics as it followed the requirement of safety [10]. Detailed explanation on why they used all this material will be discussed in the next section.

Sewing: In this stage, art students were trained by their teacher to sew the fabrics to the shape of the robot.

Fitting: Once the costume is ready, the students tried to fit their design to the actual robot as shown in Figure 1.

Final trimming: In this final stage, most of the students need to do the final trimming to fit the eye of the robot.

4 Selection of robot costume for child-robot interaction

In previous section, we discussed the design criteria and processes of creating the prototype of LUCA's costume. The selection of costumes was done based on their presentation and justification of their innovation. Most of the students had very idealistic reasons and good motivations in creating the costume such as selection of colors, arts values and most importantly the theme of their innovative design. Overall, 11 designs were made by 11 students in this study as illustrated in Figure 2.

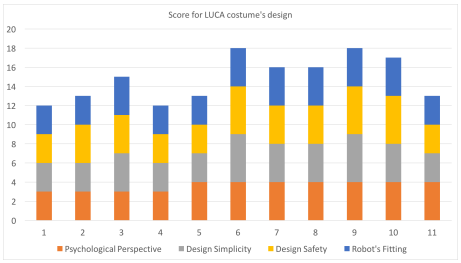

Fig. 3: Bar chart representation of all costume design score

At the end of the study, all students required to present their invention and justify the reason behind their design. Their presentation was very interesting and so meaningful. Most of the students were able to relate their design concept from arts value, psychological perspectives, design safety and the future task of the robot. As mentioned earlier, LUCA robot will be used to perform some child-robot interaction such as facial expression and simple head-turn. Additionally, most of the students also able to relate some of the potential psychological effects in their presentation story which makes their costume very useful for future child-robot interaction study. Moreover, the art students eventually able to talk about the basic thing about a robot such as, robot's hardware and software, degree of freedom of the robot, capability of the robot in making facial expressions and etc.

Fig. 4: a) LUCA costume RED, b) LUCA costume blue

In achieving the second objective of the study, we only select the best two designs for future (actual) experiment of child-robot interaction between LUCA and children with cognitive impairment. The final two LUCA's costumes design was selected based during their final design presentation. We evaluated their costumes design based on specified design criteria as mentioned in previous section which are (1) Selection of colour for robots costume must have some psychological effect towards children with cognitive impairment, (2) The design should be simple but interesting, (3) No dangerous materials shall be used in fabricating the costume such as metal and hazardous items, (4) The fitting of the costume shall not disturb the robots capabilities and functions [3] (i.e. facial expression, head to turn left and right).

In the selection process, marks were given to all costumes during their costume presentation based on mentioned criteria. 5 full marks were allocated for each criteria, which yield to the total score of 20 marks for 4 criteria. . The scale of the marks depend on the achievement of each criteria. For example (1) Very Bad (2) Bad (3) Average (4) Good (5) Very Good. The overall score of design costume can be seen as illustrated in Figure 3. Costume design number 6 and 9 obtained the highest marks. Their costumes design are shown in Figure 4a and Figure 4b. These were the best among others and had qualified them to obtained the highest score as compared to others. Their design was successfully incorporated arts to the robot's costume while considering positive psychological perspective towards social interaction in future child-robot interaction. It is amazing that the art students could relate arts, with psychology and robotics in their costume's design. Moreover, this make them feel more excited and be proud of their design since their design will be used in future child-robot interaction study. This is very meaningful for young and talented secondary arts students and they feel honored if their design could be useful for children with cognitive impairment.

5 Conclusion and future work

In this article, we presented a study which incorporated robots, arts, psychology and education. We had worked together with art students to build interesting robot costume with some psychological perspectives. By working together the results of the research finding can be greatly impact on the children with cognitive impairment and beneficial towards society. Research that integrate robots, arts, psychology and education is still very limited. Thus, we tried to contribute to the research community the integration of robot, arts, psychology and education by sharing our research work and finding. Our goal (1) to educate art students in secondary art students on the importance of arts elements in social robotics appearance for children with cognitive impairment has been significantly achieved and proved that nothing is impossible if we work together and guide the student educationally. Moreover, the second objective (2) to select the best costume for future child-robot interaction study with children with cognitive impairments also successfully achieved since all the costume are good and impressive. Most

importantly, their design did not distract the functionality of the robot and safe to use for future child-robot interaction. To conclude, it is our hope that more future work that incorporate arts, psychology, robotics and education shall be carried out in the future work so that more people will get the benefits while learning things across multiple field of knowledge.

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